

Guidelines for Safe Storage of Flammable Materials

Flammable and Combustible Liquids

Since the advent of the industrial revolution, the use of non-water-based chemicals has increased dramatically. Exposure to the hazards associated with these chemicals has also increased.

One potential hazard is flammability. To prevent fires, hazardous liquids need special precautions taken for their storage, handling and use. The National Fire Protection Agency (NFPA) and the International Code Council (ICC) have developed guidelines for the safe storage and use of flammable and combustible liquids under the Uniform Fire Code. These guidelines are not mandatory unless a federal, state or local authority chooses to use them.

Mandatory regulations have been developed, however, by Occupational Safety and Health Administration (OSHA). OSHA has specified safe handling practices in three (3) separate mandatory regulations for:

- General Industry (29 CFR 1910.106)
- Construction Industry (29 CFR 1926.152)
- Shipyard Industry (29 CFR 1915.36)

For the purpose of this document, only the requirements of the General Industry will be discussed.

Defining Flammable and Combustible Liquids

To understand OSHA requirements for the safe storage of flammable and combustible liquids, we must begin by defining the two. The flashpoint and boiling point determine the class of a liquid.

A **flammable liquid** is any liquid having a flashpoint below 100° F (37.8°C) (except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99 percent or more of the mixture)(1910.106(a)(19)).

Flammable liquids are categorized into three groups, as follows:

Class IA Flammable Liquid

Liquids having flashpoints below 73°F (22.8°C) and having boiling points below 100°F (37.8°C) (1910.106(a)(19)(i)). Examples: Acetaldehyde, ethyl ether and cyclohexane.

Class IB Flammable Liquid

Liquids having flashpoints below 73°F (22.8°C) and having boiling points at or above 100° F (37.8°C) (1910.106(a)(19)(ii)). Examples: Acetone, benzene and toluene.

Class IC Flammable Liquid

Liquids having flashpoints at or above 73°F (22.8°C) and below 100° F (37.8°C) (1910.106(a)(19)(iii)). Examples: Hydrazine, styrene and turpentine.

A **combustible liquid** is any liquid having a flashpoint at or above 100°F (37.8°C) (1910.106(a)(18)). Combustible liquids are divided into two classes:

Class II Combustible Liquid

Liquids having flashpoints at or above 100°F (37.8°C) and below 140°F (60°C), except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the volume of which make up 99 percent or more of the total volume of the mixture (1910.106(a)(18)(i)). Examples: Acetic acid, naphtha and stoddard solvent.

Class III Combustible Liquid

Liquids having flashpoints at or above 140°F (60°C) (1910.106(a)(18)(ii)). Class III liquids are subdivided into two subclasses:

Class IIIA Combustible Liquid

Liquids having flashpoints at or above 140°F (60°C) and below 200°F, except any mixture having components with flashpoints of 200°F (93.3°C) or higher, the total volume of which make up 99 percent or more of the total volume of the mixture (1910.106(a)(18)(ii)(a)). Examples: Cyclohexanol, formic acid and nitrobenzene.

Class IIIB Combustible Liquid

Liquids having flashpoints at or above 200°F (93.3°C) (1910.106(a)(18)(ii)(b)). Examples: Formalin and picric acid. Per 1910.106(a)(18)(ii)(b) "Class IIIB liquids" shall include those with flashpoints at or above 200°F (93.3°C). This section does not cover Class IIIB liquids. Where the term "Class III liquids" is used in the section, it shall mean only Class IIIA liquids. (Class IIIB is used in this document for reference purposes only.)

***Note:** When a combustible liquid is heated for use to within 30°F (16.7°C) of its flashpoint, it shall be handled in accordance with the requirements for the next lower class of liquids (1910.106(a)(18)(iii)).

Whether a liquid is a Class IB Flammable Liquid or Class IIIA Combustible Liquid is not the only factor you should consider when determining your safe storage needs. You also need to consider ignition temperature, explosive limits (LEL or UEL), vapor pressure, specific gravity and vapor density if you want to design a truly safe storage system.

Flammable and Combustible Liquids Safety Cans

One technique to reduce the hazards associated with flammable and combustible liquids is the use of safety cans. OSHA defines a safety can as:

"An approved container, of not more than 5 gallons capacity, having a spring-closing lid and spout cover and so designed that it will safely relieve internal pressure when subjected to fire exposure" (1910.106(a)(29))."

This definition allows a wide variety of containers to be considered safety cans. However, many local laws and insurance carriers require safety cans to be Factory Mutual (FM) or Underwriter Laboratory (UL) approved. These two organizations are nationally recognized independent testing laboratories to which manufacturers submit products for evaluation of their ability to meet safety requirements under intended use. Products that meet the requirements are given either a UL product or FM approved. OSHA recognizes both FM and UL.

In addition, 29 CFR 1910.106 limits the amount of liquid in a single [safety can](#). The following chart shows the allowable amounts for each class of liquid.

MAXIMUM ALLOWABLE SIZE OF CONTAINERS AND METAL PORTABLE TANKS

Container Type	Flammable Liquids		Combustible Liquids		
	Class IA	Class IB	Class IC	Class II	Class III
Glass or approved plastic	1 pint	1 quart	1 gallon	1 gallon	1 gallon
Metal (other than DOT drums)	1 gallon	5 gallon	5 gallon	5 gallon	5 gallon
Safety Cans	2 gallon	5 gallon	5 gallon	5 gallon	5 gallon
Metal Drum (DOT spec.)	60 gallon	60 gallon	60 gallon	60 gallon	60 gallon
Approved Metal Portable Tanks	660 gallon	660 gallon	660 gallon	660 gallon	660 gallon

There are exceptions to this rule:

1. Medicines, beverages, foodstuffs, cosmetics and other common consumer products, when packaged according to commonly accepted practice
2. 29 CFR 1910.106 also limits the total amount of a liquid kept outside of a [safety cabinet](#) or storage room. The quantity of liquid that may be stored outside of an inside storage room or flammable liquid storage cabinets in any one fire area of a building cannot exceed:
3. 25 gallons of Class IA liquids in containers
4. 120 gallons of Class IB, IC, II or III liquids in containers
5. 660 gallons of Class IB, IC, II or III liquids in a single portable tank
6. The amount of liquid storage and location of cabinets is regulated. 1910.106 (d)(3) states, "Not more than 60 gallons of Class I or Class II liquids, nor more than 120 gallons of Class III liquids may be stored in a storage cabinet." Also, according to NFPA 304.3.2, not more than three (3) such cabinets may be located in a single fire area.

Storage Cabinets

Another fundamental means of fire protection is the use of flammable storage cabinets. The NFPA, OSHA and UFC require flammable cabinets to be designed and constructed to specific requirements. 1910.106(d)(3)(ii)(a) states that flammable materials cabinets shall be constructed in the following manner:

1. Bottom, top and sides of cabinet shall be at least No. 18 ga. sheet steel
2. Cabinet must be doubled walled with 1½" airspace
3. Joints shall be riveted, welded or made tight by some equally effective means
4. Door shall have a three-point latch
5. Door sill shall be raised at least 2" above the cabinet bottom to retain spilled liquid within the cabinet
6. Cabinet shall have a "FLAMMABLE—KEEP FIRE AWAY" legend

These regulations also provide an option for wood cabinets. 1910.106(d)(3)(ii)(b) states that wood cabinets shall be constructed in the following manner:

1. Bottom, top and sides of cabinet shall be at constructed of exterior grade plywood at least 1" thick
2. Plywood shall not break down or delaminate under fire conditions
3. Joints shall be rebuttetted and fastened in two directions with flathead wood screws
4. When more than one door is used, they should have a rebuttetted overlap of not less than 1"
5. Doors shall be equipped with latches and hinges that are mounted to not lose their holding capacity when subjected to fire
6. Door sill or pan shall be raised at least 2" above the cabinet bottom to retain spilled liquid within the cabinet
7. Cabinet must have a "FLAMMABLE—KEEP FIRE AWAY" legend

In addition to the requirements listed above, the UFC (Uniform Fire Code) also requires self-closing doors. Most local authorities use one or more of these standards as a foundation for establishing local codes.

Fire Areas

OSHA does not provide a definition of a fire area in their standard. However, a fire area is defined by NFPA Code 30 (1.6.15) as, "An area of a building separated from the remainder of the building by construction having a fire resistance of at least 1 hour and having all communicating openings properly protected by an assembly having a fire resistance rating of at least 1 hour."

The NFPA also provides a special provision for the grouping of flammable cabinets in an industrial facility. Because most industrial settings do not have walls or barriers within a facility, "In an industrial occupancy, additional cabinets may be located in the same fire area if the additional cabinets, or the group of not more than three (3) cabinets, is separated from the other cabinets or group of cabinets by at least 100 feet (30 m)." (4.3.2 Exception 1)

Flammable Combustible Liquids Questions

Each year fires in homes and businesses destroy millions of dollars of property and claim numerous lives. According to the [U.S. Fire Administration](#), 2008 non-residential structures incurred approximately 112,000 fires resulting in 120 deaths, 1,400 injuries, and \$3.8 billion in property losses. Non-residential structures are locations in which we meet, learn, shop, and most of all work, outside our homes.

Proper storage and handling of flammable liquids helps reduce the number of these non-residential fires and keep losses to a minimum. OSHA compliant flammable liquid safety cabinets are designed to keep the containers stored inside at a lower temperature while OSHA compliant safety cans safely relief pressure build-up and help prevent an explosion.

OSHA [29 CFR 1910.106](#) provides the definitions for flammable and combustible liquids. It provides information for the proper storage, stored amounts, and dispensing. Below are answers to frequently asked questions regarding both mandatory requirements and best practices for the safe storage of flammable materials:

Venting of Storage Cabinets

Chemical storage cabinets, whether used for flammables, corrosives or pesticides/poisons, often come with capped bung openings that allow ventilation. While cabinet manufacturers may provide the bungs for venting, ventilation for chemical storage cabinets is NOT required or even recommended by any Federal regulatory agency. Cabinet manufacturers include venting bungs for users who are required to vent by state or local codes, or by individual company or insurance carrier policies.

Don't Vent Unless You Have To

According to NFPA (National Fire Protection Association) Code 30, *Flammable and Combustible Liquids Code Handbook*, venting a chemical storage cabinet is not necessary for fire protection purposes. Flammable and combustible liquid storage cabinets are designed to protect the internal contents from a fire outside the cabinet. A vented cabinet could compromise the ability of the cabinet to protect its contents from a fire. According to [NFPA Code 30, 9.5.4*](#), "The cabinet is not required to be vented for fire protection purposes."

[9.5.4.2](#), states; "If vented for whatever reason, the storage cabinet vent openings shall be ducted directly to outdoors in such a manner that will not compromise the specific performance of the cabinet and in a manner that is acceptable to the authority having jurisdiction."

[9.5.4.1](#), states; "If the cabinet is not ventilated, storage cabinet vent openings shall be sealed with the bungs supplied with the cabinet or with bungs specified by the manufacturer."

[NFPA Code 30](#) clearly dismisses the need to vent storage cabinets in its appendix. Under A.9.5.4 it states, "Venting storage cabinets has not been demonstrated to be necessary for fire protection purposes. Additionally, venting a cabinet could compromise the ability of the cabinet to adequately protect its contents from involvement in a fire since cabinets are not generally tested with venting. **Therefore, venting of a storage cabinet is not recommended.**"

Federal OSHA recognizes the NFPA guidelines when it comes to chemical storage cabinets, so there's no requirement to vent cabinets for OSHA compliance. However, this does not mean it is not required in some circumstances. State and local authorities having jurisdiction (AHJ) may require venting. NFPA 30 acknowledges this later in A.9.5.4., "However, it is recognized that some jurisdictions may require storage cabinets to be vented and that venting may also be desirable for other reasons, such as health and safety. In such cases, the venting system should be installed so as to not affect substantially the desired performance of the cabinet during a fire.

Means of accomplishing this may include thermally actuated dampers on the vent openings or sufficiently insulating the vent piping system to prevent the internal temperature of the cabinet from rising above that specified. Any make-up air to the cabinet should also be arranged in a similar manner. If vented, the cabinet should be

vented from the bottom with make-up air supplied to the top. Also, mechanical exhaust ventilation is preferred and should comply with NFPA, *Standard for Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal or Conveying*. Manifolding the vents of multiple storage cabinets should be avoided."

How Do I Know If I Need To Vent My Cabinet

In addition to acknowledging that the local AHJ requirements supersedes that of the NFPA, the above appendix passage identifies that venting is occasionally necessary and how it can be achieved.

The following five steps help to determine whether or not to vent a chemical storage cabinet:

- Determine Classification (Flammable, Corrosive and Oxidizer), health hazards, storage requirements (i.e. temperature, incompatibilities) and total amounts of the chemicals that will be stored in the cabinet. Refer to the Material Safety Data Sheets (MSDS) for this information or contact the manufacturer/supplier for assistance. This information may be needed for the following steps.
- Contact your local Fire Marshal/Fire Inspector to determine if venting is required by your local or state regulations. If so, obtain their instructions and any other special requirements.
- Contact your Environmental Health and Safety (EHS) Officer, if applicable. Many companies, universities, school districts and other large facilities have internal requirements for venting and storage. Again, request instructions and special requirements since they may vary.
- Consult with your insurance company for their recommendations and requirements.
- Have air quality evaluated to determine actual explosive limit value in and around the storage area. Consult an Industrial Hygienist for assistance. Your State OSHA Consultation Office will either provide you with an accredited hygienist that is on-staff, or will help you contact one in your area.

If the cabinet's contents are creating excessive levels of chemical vapors, it doesn't necessarily mean the cabinet must be vented. Before venting a cabinet to lower vapor emissions, consider the following options:

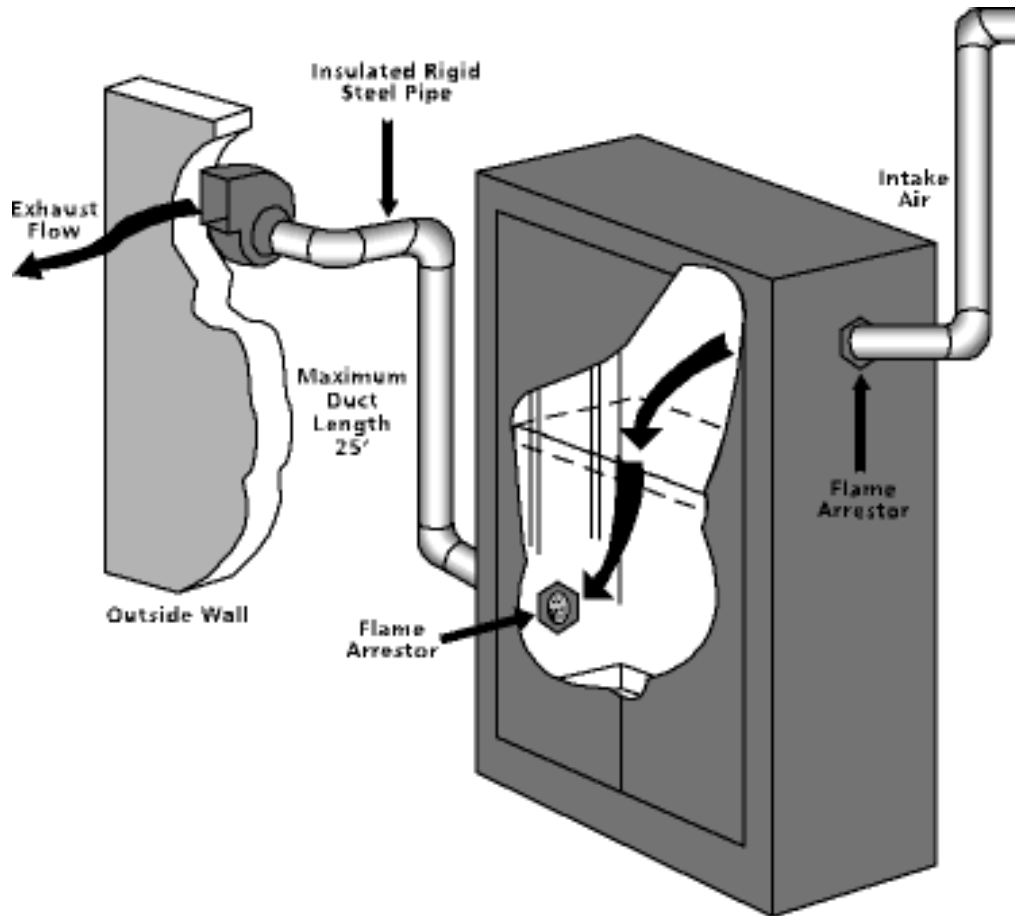
- Place cabinets in a cool, dry location out of direct sunlight and away from any possible heat or ignition source. Temperature fluctuation in many chemicals will increase harmful vapors emitted.
- Always maintain continuous and adequate room ventilation. Many accidents occur when ventilation is turned off for the weekend or an extended period of time.
- Maintain an accurate inventory of chemicals and their properties to prevent dangerous reactions resulting from incompatible chemical storage. **Never** store chemicals solely based on alphabetization, as this can result in dangerous chemical reactions.
- Store chemicals only in containers that are made of materials determined to be chemically compatible so that leakage/damage will not occur. Consult the MSDS or manufacturer for their recommendations. Frequently inspect containers for

signs of damage and aging.

- Always make sure that caps are replaced on containers tightly, and that the outside of containers is clean and free from residual liquids.
- Regularly inspect inside the cabinet for spills, and clean immediately if found.
- Regularly inspect cabinets and any metal items in surrounding area for signs of rust, corrosion or other visual indications that the vapor levels are excessive and mechanical ventilation would be needed.
- Dispose of any aging chemicals that could become unstable.
- Use of vapor absorbent inside the cabinet can also reduce the irritant level of vapors.

What If I Have To Vent My Cabinet?

- If a decision is made to vent, follow the engineering guidelines from the AHJ that requires the venting. At the very minimum, venting should incorporate the following steps:
- Remove both metal bungs from sides of cabinet and replace flame arrester screens (normally these come with the cabinets) into the openings.
- Connect the bottom opening to the exhaust fan using rigid metal tubing equivalent or better than that used in construction of cabinet. Tubing must have an inner diameter no less than that of the opening. Several places require welding of the tubing to the cabinet to avoid riveting or other methods that may impede the cabinet's fire protection. PVC should not be used since it cannot withstand excessive temperatures.
- The top opening shall serve as the fresh air inlet. The make-up air should be supplied to the fresh air inlet in tubing similar to that used for the exhaust.
- A suitable fan should be constructed of non-sparking blades and shrouds. Mechanical exhaust ventilation is preferred and should also comply with NFPA 91 *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncompatible Particulate Solids*.
- The total run of the exhaust duct should not exceed 25 feet.
- **DO NOT** manifold vents of multiple cabinets—in many localities it is prohibited.



While the above guidelines refer most specifically to flammable liquid storage cabinets, they can be modified slightly for use on corrosive or pesticide/poison storage cabinets.

Again, the AHJ that requires the venting needs to be consulted for engineering guidance to ensure their specific venting protocol is met. A couple important points to remember are corrosive cabinets require blowers that are chemically compatible with the vapors they move, and some pesticide/poison cabinets can not be vented to the outside due to potential health hazards associated with exposures to the vapors.

Corrosive/Acid Cabinets

There currently are no regulations regarding the construction of corrosive/acid cabinets, however, most manufacturers construct them of either wood or polyethylene and they are usually blue in color. The EPA does require that the cabinets be able to contain any possible spills. Polyethylene is the most common material used for acid/corrosive cabinets. Chemical compatibility is the biggest reason to use this material along with the fact that polyethylene can be welded at the seams to provide better spill protection. Wood can be another choice of material for these cabinets, but chemical handling and storage requirements should be closely evaluated since several acids are incompatible with wood and could ignite if spilled.

Acid/Corrosive cabinets are primarily vented only when required by local authorities or the company. Cabinets made from either wood or polyethylene are not typically provided with bungs. However, some manufacturers will custom make them for those very few areas where venting would be required. Metal cabinets are the final option, and most likely need to be vented to prevent rusting and corrosion. When venting a corrosive cabinet, as opposed to a flammable cabinet, connecting to an existing exhaust such as a fume hood is strongly recommended. Fume hood exhaust systems are designed to handle corrosive vapors. Flame arrestors do not need to be used and PVC is the best material for venting of corrosives.

Pesticide/Poison Cabinets

There are currently no NFPA regulations for the construction of these cabinets, other than the EPA secondary containment regulations and that the cabinet must be lockable. Cabinets for this category are often constructed to the NFPA 30 standard since more often than not these chemicals will also be flammable. Pesticide cabinets are most often green in color while Poison cabinets are most often white or gray. Venting should be avoided if at all possible. Many pesticides/poisons should not be vented outdoors due to potential health hazards. Again refer to the MSDS and/or manufacturer for storage requirements as well as EPA regulations and restrictions.

Frequently Asked Questions

Q. When dispensing flammable liquids, do I have to use bonding and grounding wires?

A. According to 1910.106(e)(6)(ii), only Class I liquids are required to be bonded and grounded. However, for your own safety, bonding and grounding should always be used when dispensing flammable or combustible liquids.

Q. Am I required to have a flammable storage cabinet?

A. OSHA does not require the use of flammable storage cabinets unless the total amount of flammable and/or combustible liquids reaches a given amount. Local authorities and insurance companies may require the use of flammable storage cabinets in quantities less than that of OSHA.

Q. What is the difference between type I and type II safety cans?

A. A Type I safety can has one spout for both pouring and filling. A Type II safety can has two openings, one for pouring and one for filling.

Q. What is a flame arrestor, and what purpose does it serve?

A. A flame arrestor is a mesh or perforated metal insert within a flammable storage container (safety can, cabinet) that protects its contents from external flames or ignition. It also dissipates heat. All Type I, Type II, disposal and specialty cans include a flame arrestor.

Q. Are flammable cabinets required to have mechanical ventilation?

A. OSHA does not normally require the use of mechanical ventilation. The NFPA recommends that cabinets not be mechanically ventilated, but if they are, they should

be ventilated in accordance to NFPA 91 Exhaust Systems for Air Conveying of Materials.

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Q: What is the difference between Type I and Type II safety cans?

A: A Type I safety can has one spout for both pouring and filling. A Type II safety can has two openings: one for pouring and one for filling.

Q: How are these safety cans different from the economical plastic gas cans they carry at the local hardware store?

A: Approved Type I and II safety cans that are constructed out of HDPE and are used when the flammable liquid is highly corrosive or the can will be subject to abusive use. The local hardware store gas can is not an approved safety can and does not have the necessary safety features, such as a spring-closing lid, to allow it to be used in an occupational environment.

Q: Are flammable cabinets required to have mechanical ventilation?

A: OSHA does not normally require the use of mechanical ventilation. The NFPA recommends that cabinets not be mechanically ventilated, but if they are, they should be ventilated in accordance to NFPA-91, Exhaust *Systems for Air Conveying of Materials*.

Q: How do I know what color my flammable liquid storage cabinet must be?

A: The color of a flammable cabinet is not specified with in 29 CFR 1910.106. However, within the industry the color [yellow](#) has been adopted as the color of the typical flammable storage cabinet — along with the color [red](#) for aerosol flammable storage, and [blue](#) as acid/base flammable liquid storage.

Q: Do I need self-closing doors on my flammable liquids safety cabinet?

A: OSHA and NFPA do not require self-closing doors, however, it is a requirement in the Uniform Fire Code (UFC). Many west coast states, Hawaii and Alaska may follow the requirements of UFC, as well as some local cities and/or counties. To determine if you are required to have self-closing doors on your flammable liquids safety cabinet, it is always best to check with your local/state Fire Marshal or the authority having jurisdiction.

Q. What is a flame arrester?

A. A flame arrester is a special fine metallic screen that prevents back flow or flashbacks of flames. Designed to allow liquids and vapors to pass through, it provides a barrier to flame passage if the vapors on either side should ignite.

Q. Do I need separate flammable and combustible cabinets?

A. No, provided that the total amount stored in the cabinet does not exceed 120 gallons of which only 60 gallons may be from Class I and Class II. Also note that no more than three of these cabinets may be stored in the same fire area, unless there is a separation of greater than 100 feet.

Q. Do I need self-closing doors?

A. Self-closing doors are not a NFPA requirement; however, the Uniform Fire Code 66 does require that all flammable cabinets have self-closing doors. Many States and local codes do require compliance with the UFC. To find out if you are in an area with this additional requirement, contact your local Fire Marshall.

Flammable and Combustible Liquid Resources

Sources for More Information:

- National Institute of Occupational Safety & Health, [Pocket Guide to Chemical Hazards](#), U.S. Department of Health and Human Services. (Washington: GPO 2005).
- National Fire Protection Association, [Flammable and Combustible Liquids Code Handbook](#), Sixth edition, ed. Robert Benedetti, 1996.
- United States Office of the Federal Register National Archives and Records Administration, 29 Code of Federal Regulations Parts 1900 to 1910, (Washington: GPO 1994).
- [International Code Council](#)
- [National Fire Protection Association](#)
- [Occupational Safety and Health Administration \(OSHA\)](#) Flammable and Combustible Liquids